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ANALYSIS OF MATHEMATICAL METHODS FOR DESCRIBING FINANCIAL FLOWS: DYNAMIC MODELING OF AN INNOVATIVE COMPANY

Purpose. Development of a dynamic mathematical model of an innovative company operating in accordance with Ukrainian legislation, allowing for the analysis and adjustment of its financial activities.

Methodology. When developing a model and description of financial flows, a factor analysis of the necessary indicators of the financial condition of the enterprise in question was carried out, which were used in the calculations of the presented mathematical modeling. A mathematical apparatus has been developed for calculating financial indicators depending on time. Using inductive, deductive and logical methods, an analysis of the financial situation for the year was carried out.

Findings. The main methods and tools for describing financial flows have been analyzed. Mathematical modeling of the innovative company is carried out, which allows analyzing the costs of the enterprise and determining the size of its free funds. The calculation of financial indicators of the enterprise, which are demonstrated in the form of tables, is performed and the dynamics is shown in charts and graphs. All calculations were made on the basis of existing Ukrainian legislation using modern information technologies.

Originality. A mathematical dynamic model of changes in financial flows at the enterprise has been developed and implemented. The proposed model takes into account various items of expenses and profits in accordance with the state legislation. Calculations allow for dynamic analysis and determination of the impact of various indicators on the financial condition of the enterprise, which allows for faster adoption and implementation of decisions in managing financial flows. This dynamic model is a convenient tool for any enterprise in Ukraine.

Practical value. The results that were obtained during the study can become the basis for creating the necessary digital tools for researching, analyzing and adjusting the financial flows of a particular enterprise. Now methods are available that allow analyzing and describing financial flows more accurately and forecasting their changes in the future. The methodology presented allows the creation of dynamic models that can account for complex dependencies between different indicators and forecast the behavior of financial flows in real time. The financial model allows the simulation of cash flows of planned activities and the evaluation of financial planning in advance, taking into account the conducted research. It is straightforward to use and allows the analysis of different scenarios of business development, significantly reducing the time required.

Keywords: *financial flows, mathematical model, profit, free financial resources*

Introduction. Cash flow is a multifaceted economic phenomenon, it affects the financial results of the enterprise and therefore requires careful research. Many researchers have studied the behavior of financial flows for several centuries.

In various fields of science, mathematics is an impeccable working tool. It is not an exception to use a mathematical apparatus for the generalization and analysis of flow processes that reflect the temporal and spatial nature of the distribution of financial resources. In the pre-computer era, the development of models describing financial flows depended on the limited resources and physical capabilities of the performers. This even led to the impossibility of practical use of some models, for example, due to the large volume of data, insufficient speed of calculations and their accuracy, and fatigue and human errors also had their influence. Previously available methods for modeling financial flows were quite limited in their capabilities, only with the advent of computers that work quickly and have a sufficient amount of memory, it became possible to take into account a large number of parameters, their interdependence and influence on the economic system as a whole.

For the formal description of financial flows in the 20^{th} century, matrix methods, factor and functional analysis, methods of describing and optimizing financial flows on graphs, etc. were used. The listed methods were quite limited and required a significant amount of manual work for their application. Later, from the end of the 20^{th} century, methods that take uncertainty into account, such as fuzzy set methods, the conceptual apparatus of system dynamics, etc., appeared. The use of computer technology made it possible to use the methods for describing financial flows in automatic mode, taking into account a much larger number of factors. In the 21^{st} century, the approach to describing and researching financial flows of enterprises, banks, and states as a whole has fundamentally changed. Machine learning and big data analysis methods are now available, which allow more accurate description of financial flows and predict their changes in the future [1]. For example, neural network techniques can be used to create models that can take into account complex dependencies between different indicators and predict the behavior of financial flows in real time [2].

Literature review. We will analyze the main methods and tools for describing financial flows. We will review them in the order in which they appeared over time.

1. Matrix models and methods in modern economic activity are often used in the field of description, forecasting and planning of financial flows of enterprises of various levels. The matrix model has the form of a table, in which the elements give a description of the relationship of objects. It is widely used for financial analysis because it has a simple and clear form of combining disparate but interdependent economic phenomena [3].

The most famous matrix model used by companies when analyzing their activities is the BCG model. It appeared as a result of research work by employees of the consulting company Boston Consulting Group; the BCG approach became vital for the development of strategies and led to the emergence of analytical models that carry a similar BCG content [4]. Such models include GE/McKinsey and Shell/DPM (Direct Policy Matrix).

2. Factor and functional analysis are the following methods that can be used to describe the financial flow.

From the point of view of modeling the financial flow, it is the factor analysis that allows you to identify those factors that have an impact on the financial flow, such as exchange rates, interest rates, tax rates, etc., and use them further in modeling [5]. In addition, factor analysis is used in planning, as well as financial risk management. For example, the American economist William Sharp uses factor analysis to study the relationship between actions on the stock market. He developed a model used to predict future stock price movements.

Functional analysis deals with the study of the behavior of functions (it can be, for example, a time series), finding some properties and important regularities of functional dependencies. In the context of financial flow, functional analysis allows studying the behavior of financial flow, looking for trends and cyclicality. Functional analysis is used to study time series of financial data: changes in currency rates, changes in interest rates, trading volumes on the stock market, etc.

The described methods of analysis are used in risk management and portfolio management. With the help of factor analysis, it is possible to identify the main factors affecting the profitability of the portfolio and determine the optimal distribution of assets in the portfolio. Functional analysis is used to predict future changes in asset prices and determine the optimal time to buy and sell assets. In general, the types of analysis discussed above are important tools of financial analysis and planning.

3. Graph theory is a branch of mathematics that is popular in various fields, including economics, and allows one, thanks to its convenience and visibility, to analyze the relationships between objects and solve complex problems. When modeling financial flows, you can, for example, use graphs to create and explore relationships between financial accounts or companies. To do this, we can construct a graph in which vertices represent financial accounts or companies, and edges represent financial flows between them. An edge can be directed if the flow goes in one direction, such as from a supplier company to a buyer company, or undirected if the flow goes in both directions, such as between two bank accounts. Such a graph allows you to analyze the movement of financial flows, find bottlenecks in it, carry out optimization by redirecting flows, and also helps in the fight against fraudulent transactions by identifying suspicious connections [6]. In addition, directed graphs allow you to build networks that are convenient for visual analysis and solve optimization problems on them [7, 8].

4. Methods of fuzzy sets (Fuzzy Logic) are also present in financial analysis when modeling financial flows. Fuzzy sets and the corresponding mathematical apparatus that uses them make it possible to make decisions in conditions of uncertainty, to overcome the vagueness of those indicators that affect the economic system [9]. Examples of the use of the fuzzy set method in price forecasting, risk modeling, pattern recognition (for example, to determine support and resistance levels, which allows for a more accurate assessment of the probability of future price changes and to apply the optimal time for buying and selling financial instruments) can be given.

5. The methods of system dynamics are associated with the name of the famous scientist Jay Forrester. He solved the problem of finding the reasons for the success or failure of companies through the application of his engineering experience. Forrester was able to show that the instability of the number of employees was not related to external influences, but depended on the structure of the firm in the middle. The scientist further developed this project and brought it to formal modeling using computer technology [10]. The development of this method was the appearance of the first modeling language based on system dynamics – SIMPLE (Simulation of Industrial Management Problems with Lots of Equations), which was developed by Richard Bennett. The next stage was the appearance of an improved version of SIMPLE – DYNAMO (DYNAmic MOdels), the authors of which were Phyllis Fox and Oleksandr Puch. After that, it became a standard in business activity and is still used today.

Methodology for building a system-dynamic model. First, it is necessary to analyze and select all economic indicators that must be used in a specific model. They are chosen depending on the questions to be answered. The following factors must be included in each model: economic, legal, organizational, technical, labor, financial, historical. Their interrelationship is to be analyzed, as well as influence the entire system. Most often, when developing a specific model of system dynamics, enterprises count from 30 to 300 influencing factors. The smallest number of them usually corresponds to the main indicators that are the most important for decision-making by company managers. The maximum number is limited by the possibilities of human perception of this system when describing all relationships.

The rapid development of computer technology and its computational capabilities have significantly changed the approach to the creation of economic models and in making financial decisions when managing an enterprise when these models are used. To make informed decisions, modern companies create an information network within their enterprise and connect it to corporate global networks [11]. Currently, such financial information systems contain the necessary legislative and legal acts, have access to registration systems related to banking systems and stock exchanges.

When managing an enterprise, especially its financial condition, it is important to use an information system that should be effective and have functions of planning, management and analysis. In connection with the large flow of information and the volume of financial flows, with the advent of modern computer technologies, the requirements in the methodology of modeling financial flows of various levels have also changed in the *21st* century. Therefore, some tools have appeared for using existing methods and improving them. We will present an analysis of modern tools that implement various methods for modeling the description of the financial state of enterprises with the possibility of adjusting and planning their activities:

6. Spreadsheets – such as Microsoft Excel or Google Sheets [12], are used to create tables that can help analyze financial flows based on data entered manually or imported from other sources. In fact, these are modernized matrix methods that allow using a computer to automate the processes of calculation and data processing.

7. Financial information systems (FIS) are software products that collect, process and manage information about financial transactions within the organization. They can generate automated reports and analyze budget, cash flow, and performance data. The purpose of FIS is to combine management strategy with modern information technologies. At the same time, data analysis, decision-making systems with information support, electronic document management and record keeping are used [13]. As an example, popular FIS are FRP (Finance Requirements Planning) – used in planning the company's finances, BIS (Banking Information System) – computer programs and technologies that allow banks to automate the management of banking operations, keep records of their customers' operations, identify risks, make appropriate decisions and ensure data security.

8. Forecasting systems are systems that use mathematical apparatus, namely data analysis, testing of statistical hypotheses, construction of mathematical models for forecasting financial flows. These include SAP Predictive Analytics [14] or IBM SPSS. SPSS programs are used in various fields of research because they work with different types of data and have applications in the field of business analytics [15]. The SPSS product line is based on four software platforms: 1. IBM SPSS Data Collection for collecting and cleaning data, conducting surveys. 2. IBM SPSS Statistics for data research using methods of statistical processing and visualization of results. 3. IBM SPSS Modeler to identify regularities hidden in large arrays of information. 4. IBM SPSS Collaboration and Deployment Services for embedding analytical functions in business processes and integrating SPSS capabilities into applications.

9. Accounting programs allow you to manage the financial activities of the enterprise, document accounting, and make reports. The most famous are 1C, QuickBooks or Sage. They are very common in use, as they prevent errors in calculations, and also automate the calculation operations themselves [16]. The best programs for accounting: FreshBooks – accounting for small and medium-sized businesses [17]; ZohoBooks – popular online accounting service with wide functionality; QuickBooks

– accounting for freelancers and small companies [18]; Sage – service with the possibility of choosing accounting solutions.

10. Toolkit of simulation models of system dynamics. Progress in computer technologies and their capabilities made it possible to move the method of system modeling to another modern level. First, cognitive modeling is carried out, when cause-and-effect relationships are found between the objects used in the model, dependencies are tracked, and their nature [19]. Secondly, it is possible to proceed precisely to the construction of a simulation model of system dynamics with computer implementation in the environment of programs, for example, Powersim Studio [20], which support methods of system dynamics. The advantages of the Powersim system are built-in optimization algorithms, probabilistic modeling, parallelization of calculations, as well as the possibility of developing multidimensional models. In addition, the developed model can be integrated into the existing information system of the enterprise and used in decision-making. When considering the calculation of a certain model, it can be noted that it takes place in a fairly short period of time, while the simulated dynamic model created allows for a quick analysis of the system's response to various initial data and external influences and, based on this, to make management decisions.

Isolation of previously unresolved parts of the general problem. Today's realities indicate that the efficiency of any company's activity is largely determined not by the amount of profit received, high rates of growth of assets or sales volumes, but by its ability to sustainably generate financial flows. It is the size and dynamics of financial flows that determine the investment attractiveness of the company. Based on this, at this time the problem of finding the most effective tools for managing financial flows is becoming particularly relevant.

Therefore, it is necessary to know the currently existing methods and tools for describing and researching financial flows, their limits of use for specific enterprises. Recently, special interest has been shown in artificial modeling of financial flows. But models for calculations and modeling of various scenarios depending on the initial data and activities of a specific company, taking into account the Ukrainian tax legislation, are practically not found in scientific publications. Therefore, this work presents a mathematical model that takes into account all these points and can be applied by a certain enterprise in Ukraine.

Formulation of the purpose and setting of tasks. The purpose of the work is to develop a dynamic mathematical model of an innovative company, which makes it possible to analyze and correct its financial activities. The model of financial flows, built on the basis of dynamic modeling methods, makes it possible to analyze the company's expenses and determine the size of its free funds. With the help of such modeling, you can calculate the amount of net profit. In cases where a decision is made to improve the quality of the product, free funds can be spent on the purchase of more advanced equipment, upgrading the qualifications of employees at the enterprise.

Methodology description. We will use factor analysis to build a dynamic economic-mathematical model of the enterprise, which operates within the framework of Ukrainian legislation, analyzed all factors that have an impact on the financial state of the enterprise. When analyzing the economic activity of an enterprise, net profit is defined as gross profit after taxes. In turn, the gross profit is equal to the difference between the amount received from the sale of the product and the amount that constitutes the cost price of the sold batch of the product.

In the presented model of costs included in the cost of goods, the following items are selected:

- raw materials and supplies;
- wages of workers;
- salary of administrative and management personnel (AMP) and engineering and technical workers (ETW);
- depreciation expenses;
- payment of rent for buildings, industrial and commercial spaces;
- commercial expenses (advertising, business trips, professional development, etc.).

Labor compensation is divided into labor compensation for workers, as well as AMP and ETW, since the first depends on the volume of production (in the actual model, the piecework form of payment for the main workers is adopted), and the second can be attributed to fixed costs, that is, those that do not depend on the quantity manufactured goods.

To get the net profit, it is necessary to pay taxes and deductions from the gross profit. The following taxes are taken into account in the model under consideration:

1. The single social contribution is calculated on wages: it is transferred together with the payment of wages and makes up 22 % of its amount. And 19.5 % is withheld from the wages of employees (18 % personal income tax + 1.5 % military tax).
2. Value Added Tax (VAT): this tax is one-sixth of the price and is calculated on the amount received from the sale of each unit of the product.
3. Income tax: is 18 % of gross profit.
4. Other taxes and deductions: this value includes various deductions that do not depend on the number of products produced or sold, so it can be set in the actual model as a constant.

The main sought-after value of this model is the $LAF(t)$ variable, which shows the level of free funds on the company's account. It is determined by the following formula

$$LAF(t_i) = LAF(t_{i-1}) + RT(t_i) + WT(t_i) - STFM(t_i) - \\ - STMM(t_i) - STMW(t_i) - DR(t_i) - \\ - STPR(t_i) - STBE(t_i) - STPT(t_i),$$

where LAF is the level of funds available to the enterprise at the current moment. Other values are calculated as follows

- RT – receipt of money from retail trade

$$RT(t) = \sum_{i=1}^{n} S_i; \quad S_i = K_i \cdot PRT,$$

where S_i is the amount of funds received from the i^{th} trading point in one day; PRT – retail price of a product unit; K_i – the number of units of goods sold per day;

- WT – the receipt of money from wholesale trade

$$WT = L_i \cdot PWP,$$

where PWP is the wholesale price of a product unit; L_i – the number of units of goods sold per day;

- $STFM$ – transfer of funds for materials

$$STFM = \sum_{j=1}^{m} QM_j \cdot PM_j,$$

where QM_j is the amount of the j^{th} material that is required for the production planned at the next stage, PM_j – price per unit of material of the j^{th} type;

- $STMM$ – the transfer of money to the ETW and AMP salary fund is a constant value and depends on the rate of each position and the number of people occupying it;

- $STMW$ – transfer of money to the workers' wages fund

$$STMW = \sum_{j=1}^{31} SP_j \cdot SW_j,$$

where SP_j is the rate of payment to workers for the production of a unit of goods; SW_j – the rate of production;

- DR – deduction for the purchase and repair of fixed assets of production;

- $STPR$ – transfer of funds for payment of rent;

- $STBE$ – transfer of funds to repay commercial expenses (all VAT expenses are taken into account);

- $STPT$ – transfer of funds for payment of taxes

$$STPT = SVAT + SIT + LT,$$

where $SVAT$ is the transfer of value added tax

$$SVAT = \frac{1}{6}\sum_{j=1}^{31}(RT(t_j) + WT(t_j) - STFM(t_j) - DR(t_j) - STPR(t_j) - STBE(t_j)),$$

SIT – income tax, which is taken once a year for the previous one

$$SIT_{12}(t_{31}) = LAF_{12}(t_{31}) \cdot 0.18,$$

LT – the amount of land tax deductions is taken monthly by the 30^{th}

$$LT(t_{28}) = STRP \cdot 0.03.$$

The variable LAF is defined as the difference between the funds coming into the account of the enterprise and the mandatory payments, including taxes, so this variable can be considered as net profit, that is, free funds.

For an adequate understanding of economic growth, we will examine the relative value of the company's profit divided by the average annual value of assets *A* as the percentage

$$EG_i = \frac{LAF_i \cdot 100\,\%}{A}.$$

The model assumes that money is distributed among expenditure items in the order in which they are described in this article; for each subsequent item of expenses, money is transferred in the amounts corresponding to the above formulas, or in the amount of money remaining in the company's account after the payment of previous expenses. The company transfers the money remaining after paying taxes and purchasing materials to the wage fund.

The main output variable of this model is the amount of free funds on the company's account or the company's debt in the event that the amount of required payments exceeds the profit from the sale of products *LAF*(*t*). In addition, the output is variable amounts that characterize the amount of funds that are transferred to the main expenditure items for the simulation period.

Numerical simulation results. The calculation of financial modeling of a private enterprise for the year 2023 is presented. Calculations were made in the Excel program. As of January 1, 2023, the following initial data were accepted: *PRT* = 120 ₴, *PWP* = 100 ₴, *PM* = 40 ₴, LAF(t_{i-1}) = 10,000 ₴, *SP* = 30 ₴.

The model was calculated on a monthly basis with daily entry of the necessary data. As an example, Table 1 for January and Table 2 for December are presented, in which the 32^{nd} line is added, where SIT – income tax for the year is calculated and the final value of free funds after its deduction is provided.

For a visual analysis of the behavior of the developed model, diagrams and a graph were built that reflect the change in the level of free financial funds (*LAF*) depending on time.

Table 1

Calculation of financial indicators of the enterprise for January 2023

t	*SW*	*K*	*RT*, ₴	*L*	*WT*, ₴	*STFM*, ₴	*STMM*, ₴	*STMW*, ₴	*DR*, ₴	*STPT*, ₴	*STPR*, ₴	*STBE*, ₴	*LAF*, ₴
1	0	0	0	0	0	0	0	0	0	0	0	0	10,000
2	100	0	0	0	0	4,000	0	0	0	0	0	0	6,000
3	112	20	2,400	40	4,000	4,480	0	0	0	0	0	0	7,920
4	98	15	1,800	50	5,000	3,920	0	0	0	0	0	0	10,800
5	105	10	1,200	70	7,000	4,200	0	0	0	0	0	0	14,800
6	86	8	960	120	12,000	3,440	0	0	0	0	0	0	24,320
7	0	18	2,160	0	0	0	0	0	0	0	0	0	26,480
8	0	0	0	0	0	0	0	0	2,000	0	0	0	24,480
9	103	16	1,920	90	9,000	4,120	0	0	0	0	0	0	31,280
10	97	11	1,320	60	6,000	3,880	0	0	0	0	0	1,000	33,720
11	112	23	2,760	130	13,000	4,480	0	0	0	0	0	0	45,000
12	99	20	2,400	80	8,000	3,960	0	0	0	0	0	0	51,440
13	106	14	1,680	90	9,000	4,240	0	0	0	0	0	0	57,880
14	0	11	1,320	0	0	0	0	0	0	0	0	0	59,200
15	0	0	0	0	0	0	12,000	30,540	0	0	5,000	0	11,660
16	88	15	1,800	150	15,000	3,520	0	0	0	0	0	0	24,940
17	120	17	2,040	100	10,000	4,800	0	0	0	0	0	0	32,180
18	102	9	1,080	80	8,000	4,080	0	0	0	0	0	0	37,180
19	95	19	2,280	60	6,000	3,800	0	0	0	0	0	0	41,660
20	100	25	3,000	90	9,000	4,000	0	0	0	0	0	3,000	46,660
21	0	17	2,040	0	0	0	0	0	3,000	0	0	0	45,700
22	0	0	0	0	0	0	0	0	0	0	0	0	45,700
23	125	20	2,400	140	14,000	5,000	0	0	0	0	0	0	57,100
24	113	22	2,640	50	5,000	4,520	0	0	0	0	0	0	60,220
25	106	13	1,560	70	7,000	4,240	0	0	0	0	0	0	64,540
26	97	21	2,520	100	10,000	3,880	0	0	0	0	0	0	73,180
27	85	18	2,160	110	11,000	3,400	0	0	0	0	0	0	82,940
28	0	20	2,400	0	0	0	0	0	0	0	0	1,500	83,840
29	0	0	0	0	0	0	0	0	0	0	0	0	83,840
30	104	23	2,760	50	5,000	4,160	0	0	0	0	0	0	87,440
31	90	21	2,520	60	6,000	3,600	12,000	36,750	0	20,967	0	0	***22,643***
total	***2,243***	***426***	***51,120***	***1,790***	***179,000***	***89,720***	***24,000***	***67,290***	***5,000***	***20,967***	***5,000***	***5,500***	

Table 2

Calculation of financial indicators of the enterprise for December 2023

t	*SW*	*K*	*RT*, ₴	*L*	*WT*, ₴	*STFM*, ₴	*STMM*, ₴	*STMW*, ₴	*DR*, ₴	*STPT*, ₴	*STPR*, ₴	*STBE*, ₴	*LAF*, ₴
1	100	20	2,400	60	6,000	4,000	0	0	0	0	0	0	170,097
2	0	30	3,600	0	0	0	0	0	0	0	0	0	173,697
3	0	0	0	0	0	0	0	0	0	0	0	0	173,697
4	123	13	1,560	120	12,000	4,920	0	0	0	0	0	0	182,337
5	120	20	2,400	100	10,000	4,800	0	0	0	0	0	0	189,937
6	115	15	1,800	110	11,000	4,600	0	0	0	0	0	0	198,137
7	100	6	720	120	12,000	4,000	0	0	0	0	0	0	206,857
8	113	11	1,320	50	5,000	4,520	0	0	2,000	0	0	0	206,657
9	0	34	4,080	0	0	0	0	0	0	0	0	0	210,737
10	0	0	0	0	0	0	0	0	0	0	0	1,000	209,737
11	130	10	1,200	100	10,000	5,200	0	0	0	0	0	0	215,737
12	120	7	840	120	12,000	4,800	0	0	0	0	0	0	223,777
13	125	4	480	60	6,000	5,000	0	0	0	0	0	0	225,257
14	113	18	2,160	70	7,000	4,520	0	0	0	0	0	0	229,897
15	124	15	1,800	90	9,000	4,960	12,000	34,770	0	0	5,000	0	183,967
16	0	24	2,880	0	0	0	0	0	0	0	0	0	186,847
17	0	0	0	0	0	0	0	0	0	0	0	0	186,847
18	125	11	1,320	100	10,000	5,000	0	0	0	0	0	0	193,167
19	110	18	2,160	80	8,000	4,400	0	0	0	0	0	0	198,927
20	100	13	1,560	60	6,000	4,000	0	0	0	0	0	3,000	199,487
21	115	20	2,400	50	5,000	4,600	0	0	3,000	0	0	0	199,287
22	100	23	2,760	140	14,000	4,000	0	0	0	0	0	0	212,047
23	0	32	3,840	0	0	0	0	0	0	0	0	0	215,887
24	0	0	0	0	0	0	0	0	0	0	0	0	215,887
25	123	10	1,200	150	15,000	4,920	0	0	0	0	0	0	227,167
26	125	7	840	130	13,000	5,000	0	0	0	0	0	0	236,007
27	118	12	1,440	60	6,000	4,720	0	0	0	0	0	0	238,727
28	109	18	2,160	160	16,000	4,360	0	0	0	0	0	1,500	251,027
29	120	16	1,920	220	22,000	4,800	0	0	0	0	0	0	270,147
30	0	35	4,200	0	0	0	0	0	0	0	0	0	274,347
31	0	0	0	0	0	0	12,000	38,070	0	26,053	0	0	198,223
									SIT	35,680			***162,543***
total	***2,428***	***442***	***53,040***	***2,150***	***215,000***	***97,120***	***24,000***	***72,840***	***5,000***	***61,734***	***5,000***	***5,500***	

Fig. 1 shows the results for January, Fig. 2 for December, Fig. 3 – for the entire year by month.

When researching the relative value of the company's profit, the value of assets was considered to be $A = 1{,}000{,}000$ ₴, then

$$EG_i = \frac{162{,}543 \cdot 100\,\%}{1{,}000{,}000} = 16.25\,\%.$$

Dynamic modeling is a modern means of control and management of the enterprise; it allows taking into account a large number of different factors, and is an integral part of successful management thanks to the analysis of many different cases of initial data. Such models can integrate with databases and use optimization modules. When modeling financial flows, you can choose the goal of introducing innovations, and simulate cash flows accordingly. The use of dynamic models allows you to optimally conduct the financial policy of the enterprise. Thus, the considered model provides an accurate and quick calculation, allows considering any possible scenarios of financial planning and finding solutions in various economic situations.

Conclusions. It should be noted that financial flows play an important role in the economic life of any company. Therefore, it is important to study the principles and methods of their management in order to achieve greater stability, since it is the financial parameters that largely determine the economic viability of the company. In the financial management of the enterprise, it is important to use a model that should be effective and have functions of planning, management and analysis.

The presented model is convenient for making management decisions because it automates the analysis of the enterprise's activities, such as: collection, processing, calculations, storage and presentation of data on the financial activities of the enterprise.

Among the main advantages of the developed dynamic model of the company's financial condition, the following stand out:

1. The possibility of modeling scenarios with the calculation of various options for the future when changing the initial data.

2. Ability to take into account the impact of random factors on financial stability and timely redistribution of financial flows.

3. Visibility of input data and obtained results, the possibility of presenting the main indicators of financial movement in the form of diagrams and graphs.

4. The possibility of studying the dynamics of interaction of system elements in time and space.

5. Ensuring efficient work with financial flows and increasing productivity and making the right decisions in business.

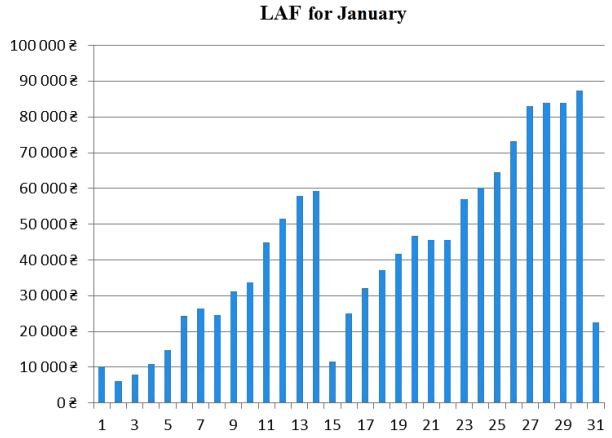

Fig. 1. Diagram of free funds for January

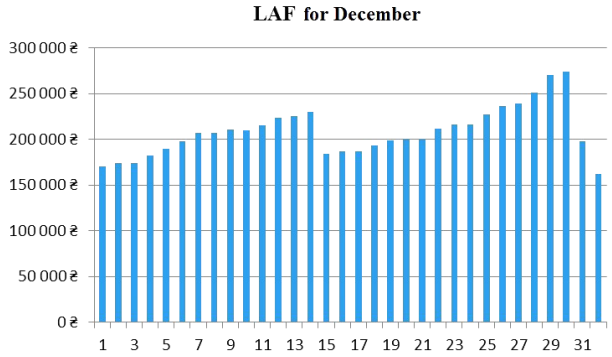

Fig. 2. Diagram of free funds for December

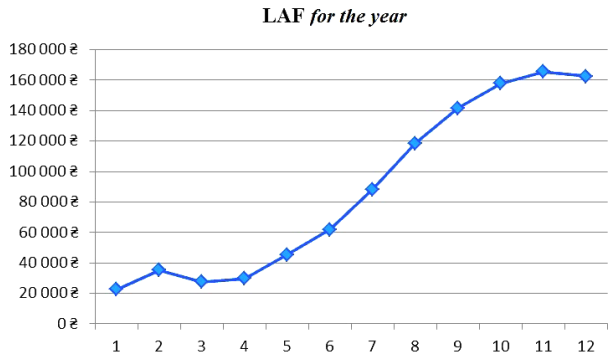

Fig. 3. Schedule of free funds for the year

In general, it should be borne in mind that any models and methods of financial flow analysis are applicable to rapidly changing conditions. Therefore, we need not only approaches that are ready for direct use, but also their dynamics, which can adapt the corresponding models to existing needs. However, it should not be forgotten that making the right decisions in financial analysis requires not only the use of mathematical methods and computer technologies, but also expert knowledge, experience and intuition [21]. Therefore, to achieve the best results, it is necessary to combine mathematical methods with human qualities and knowledge.

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Аналіз математичних методів опису фінансових потоків: динамічне моделювання інноваційної компанії

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Мета. Розробка динамічної математичної моделі інноваційної компанії, що працює за українським законодавством, яка дає можливість аналізувати й коректувати її фінансову діяльність.

Методика. При розробці моделі та опису фінансових потоків було проведено факторний аналіз необхідних показників фінансового стану розглянутого підприємства, що надалі використовувалися у розрахунках представленого математичного моделювання. Розроблено математичний апарат для підрахунку фінансових показників за часом. За допомогою індукційних, дедуктивних і логічних методів проведено аналіз фінансового стану за рік.

Результати. Проаналізовані основні методи та інструменти опису фінансових потоків. Проведене математичне моделювання інноваційної компанії, яке дає можливість проаналізувати витрати підприємства й визначити розмір його вільних коштів. Проведено розрахунок фінансових показників підприємства, що продемонстровані у вигляді таблиць, а динаміка показана на діаграмах і графіках. Усі розрахунки проводилися на основі існуючого українського законодавства з використанням сучасних інформаційних технологій.

Наукова новизна. Розроблена та впроваджена до використання математична динамічна модель змін фінансових потоків на підприємстві. Запропонована модель ураховує різні статті витрат і прибутку відповідно до державного законодавства. Розрахунки дозволяють проаналізувати в динаміці й визначити вплив різних показників на фінансовий стан підприємства, що дозволяє прискорити прийняття та впровадження рішень при керуванні фінансовими потоками. Дана динамічна модель є зручним інструментом для будь-якого підприємства на території України.

Практична значимість. Результати, що були отримані у ході дослідження можуть стати основою для створення необхідних цифрових інструментів дослідження, аналізу й коректування фінансових потоків конкретного підприємства. Тепер доступні методи, які дозволяють аналізувати та більш точно описувати фінансові потоки, й прогнозувати їхні зміни в майбутньому. Представлена методологія дозволяє створювати динамічні моделі, що можуть ураховувати складні залежності між різними показниками та прогнозувати поведінку фінансових потоків у реальному часі. Фінансова модель дозволяє імітувати грошові потоки запланованої діяльності й оцінювати наперед фінансове планування, з урахуванням проведених досліджень. Вона є зручною у використанні та дозволяє аналізувати різні сценарії розвитку бізнесу, істотно заощаджує час.

Ключові слова: *фінансові потоки, математична модель, прибуток, вільні фінансові кошти*

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